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BRYOPHYTE SPORES FROM HUNGARIAN EARLY CRETACEOUS ROCKS

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Abstract

From the spore-pollen assemblages of the Hungarian Lower and Middle Cretaceous sediments, 24 bryophyte-like spores are identified. Of these, the *Foraminisporis* and *Phaeocerosporites* species are placed into *Anthoceropsida*, the *Triporoletes, Couperisporites, Coptospora,* and *Aequitriradites* species into *Hepaticopsida*, the species of *Stereisporites* and *Cingutriletes* into Sphagnidae, the *Staplinisporites* and *Coronatispora* species into Bryidae. In the investigated sediments, the number of bryophyte spores is low, their stratigraphic importance is little, but in the Tés Formation (Middle Albian) these hornwort and liverwort spores are facies-marking.

Introduction

In the latter decade in Hungary, in the area of the Transdanubian Middle Mountains, several deep drilling have made. Investigating the spore-pollen assemblages of the Early Cretaceous rocks of these deep drillings, we can establish the existence of a high number of pteridophyte spores, in which the dominant part is taken by the spores of the ancient fern families of Pteropsida (Gleicheniaceae, Cyatheaceae, Schizaeaceae). The recent descendants of these are the floral elements of our tropics, subtropics. The question arises, what part is taken by the similarly spore-bearing bryophyte in the Hungarian Early Cretaceous flora, by which groups this phylum was represented. As moss megafossils, in situ spores are comparatively few, as well as the recent and fossil bryophyte spores are not too similar to each other, it is not easy to answer the question.

Previous works

The earliest geological record of a bryophyte is the fossil hepatic, *Hepaticites devonicus,* described by *Hueber* (1961), from the Upper Devonian sediments of North America. The megafossil records of fossil bryophytes were summarized by JOVET-AST (1967). He lists a total of 68 pre-Tertiary bryophytes (17 mosses and

9 liverworts from the Palaeozoic; 8 mosses and 34 liverworts in the Mesozoic.) He considers the Jurassic liverworts, in agreement with KRASILOV (1970), as representatives of Jungermanniales and Marchantiales. LUNDBLAD (1954) even found some spores in the fossils of the Jurassic. DETTMANN (1963) established, in the course of investigating the Lower Cretaceous sporomorphes, that the in situ spores of the fossil liverwort Naiadita lanceolata and the dispersed spores ranged into the formgenus Couperisporites were similar. The same similarity is established by him between the spores of the recent *Nothotylas, Phaeoceros* and the formgenus *Foraminisporis.*

KRUTZSCH (1963a) classified the Tertiary spores of the formgenera *Foraminisporis, Anthocerosporis, Saxosporis,* and *Rudolphisporis,* created by himself, into the Anthocerotaceae family. In another work, (KRUTZSCH, 1963b), within the Stereisporites formgenus, he created seven subformgenera and identified the Mesozoic and Tertiary forms, ranged into these, as representatives of the Sphagnaceae moss family. The expansion of this conception is to be seen in the work of DÖRING et al. (1966). It is made probable by KOTOVA (1968) that the spores of the Lower Cretaceous genera of turma Hilates, created by DETTMANN (1963) *(Coptospora, Aequitriradites, Cooksonites, Couperisporites)* are hepatic spores. She refers to UDAR's experiments (1964) with recent Hepaticae, where the creation of hilum can in a similar manner be observed as in case of the above-mentioned fossil spores. NAGY (1968) gives a summary of the moss spores of Neogene sediments in Hungary, by describing some new formgenera, formspecies. PLAYFORD (1971) ranged several Lower Cretaceous spore-forms among Bryophyta. He emphasized the priority of *Triporoletes* Mtched. 1960 over *Rouseisporites* POCOCK 1962. JARZEN (1979) described the spores of the Anthocerotaceae species and compared these with fossil Upper Cretaceous spores, as a result of which he ranged the latter forms into the extant *Phaeoceros* genus. Apart from the publications on fossil spores, as well as on the comparison of these with the recent equivalent a great help is given by the monographs on the recent moss spores, like e.g., the works of ERDTMAN (1957, 1965), BOROS et JÁRAI—KOMLÓDI (1975), in revealing the botanical relationship. The latter work is an excellent elaboration of the spores of the European mosses.

Systematic description

Phylum: Bryophyta

Classis: Hepaticopsida

Genus: Triporoletes (MTCHED. 1960) PLAYFORD 1971

1960 *Triporoletes Mtchedlishvili,* in METCHEDLISHVILI and SAMOILOVICH, pp. 127—128.
1962 *Rouseisporites* POCOCK, pp. 52—53.
1971 *Triporoletes* MTCHED. emend. PLAYFORD, pp. 551—553.

Remarks: PLAYFORD (1971) considered *Rouseisporites* POCOCK 1962 as a young synonym of the *Triporoletes* genus and, after emending the genus diagnosis, ranges the species earlier classed among *Rouseisporites,* among *Triporoletes.* SRIVASTAVA (1975) continued completing the above genus, putting several other genera in the

synonym list, not entirely without reason. As to the botanical relationship, — Playford —, refusing the angiospermoid theory of MTCHEDLISHVILI and SAMOILOVICH (1960), and based on the comparative work of DETTMANN (1963) in connection with the *Rouseisporites* species, establish a similarity with the spores of species, belonging to the Ricciaceae and Cleveaceae families of the recent hepatics.

Triporoletes radiatus (DETT. 1963) PLAYFORD 1971
(Plate I, Fig. 2.)

Remarks: The Hungarian specimens are identical in size but the zone, surrounding the spore-body, often tapers of tears off.

Triporoletes reticulatus (POCOCK 1962) PLAYFORD 1971
(Plate I, Fig. 3)

Remarks: This species shows a wide geographical and stratigraphical distribution. It occurs in the Hungarian Middle Cretaceous mainly in the fresh-water and shallow-water sediments, in a low number of specimens, thus e.g. in the coaly-clayey marl layers of the Tés Formation. (Middle Albian).

Triporoletes simplex (COOKSON et DETTMANN 1958) PLAYFORD 1971
(Plate I, Fig. 6)

Remarks: Generally there occur smaller specimens than those of the holotype in the Vértessomló Formation: it is a rare species.

Genus: Aequitriradites (DELC. et SPR. 1955) COOKS. et DETT. 1961

Remarks: DETTMANN (1963) established similarity, apart from the synonym list of the species belonging to *Aequitriradites,* between these spores and those of the recent Sphaerocarpaceae. KOTOVA (1968) published some good pictures of more than one species of the genus, where the hilum can be seen well. Evaluating UDAR's work (1964), carried out on extant hepatics, *Kotova* established that the hilum occuring in the extant hepatics, as well, is also an evidence for the Hepaticae-descent of the Cretaceous species classed into Hilates.

Aequitriradites spinulosus (COOKS. et DETT. 1958) COOKS. et DETT. 1961
(Plate I, Fig. 7)

Remarks: It occurs in the Hungarian Lower Cretaceous only sporadically. In the shallow-water sediments of the Tés Formation (Middle Albian), it is the characteristic species of the bryophyte vegetation.

Genus: Couperisporites POCOCK 1962
Couperisporites clavatoides (DEÁK 1964) n. comb.

(Plate I, Fig. 8.)

1964 *Nigrina clavatoides* DEÁK, p. 109—110.

Remarks: DEÁK (1964) described the species, frequently occuring in the marly sediments of Tés Formation, classified into the genus *Nigrina Maljawkina* 1949.

The hilum can be observed in several specimens, thus it is justified to place this species among *Couperisporites*. The sculpture elements, occurring in the zone, too, are bacula, clavae, but they are not at all similar to the spinose elements of *Couperisporites complexus* POCOCK 1962. DETTMANN (1963) published the fossil *Naiadita lanceolata*, regarding them as similar to those of the *Couperisporites* species.

Genus: Coptospora DETTMANN 1963
Coptospora sp.
(Plate I, Fig. 12)

Remarks: This spore has only occurred, so far, in two specimens together with other mainly liverwort spores, referring to a swamp-bog vegetation, in the sediments of Tés Formation.

Classis: Anthoceropsida

Familia: Anthocerotaceae

Anthoceropsida are represented by two formgenera in the Hungarian Middle Cretaceous: by the *Foraminisporis* W. KR. 1959 and *Phaeocerosporites* NAGY 1968 genera.

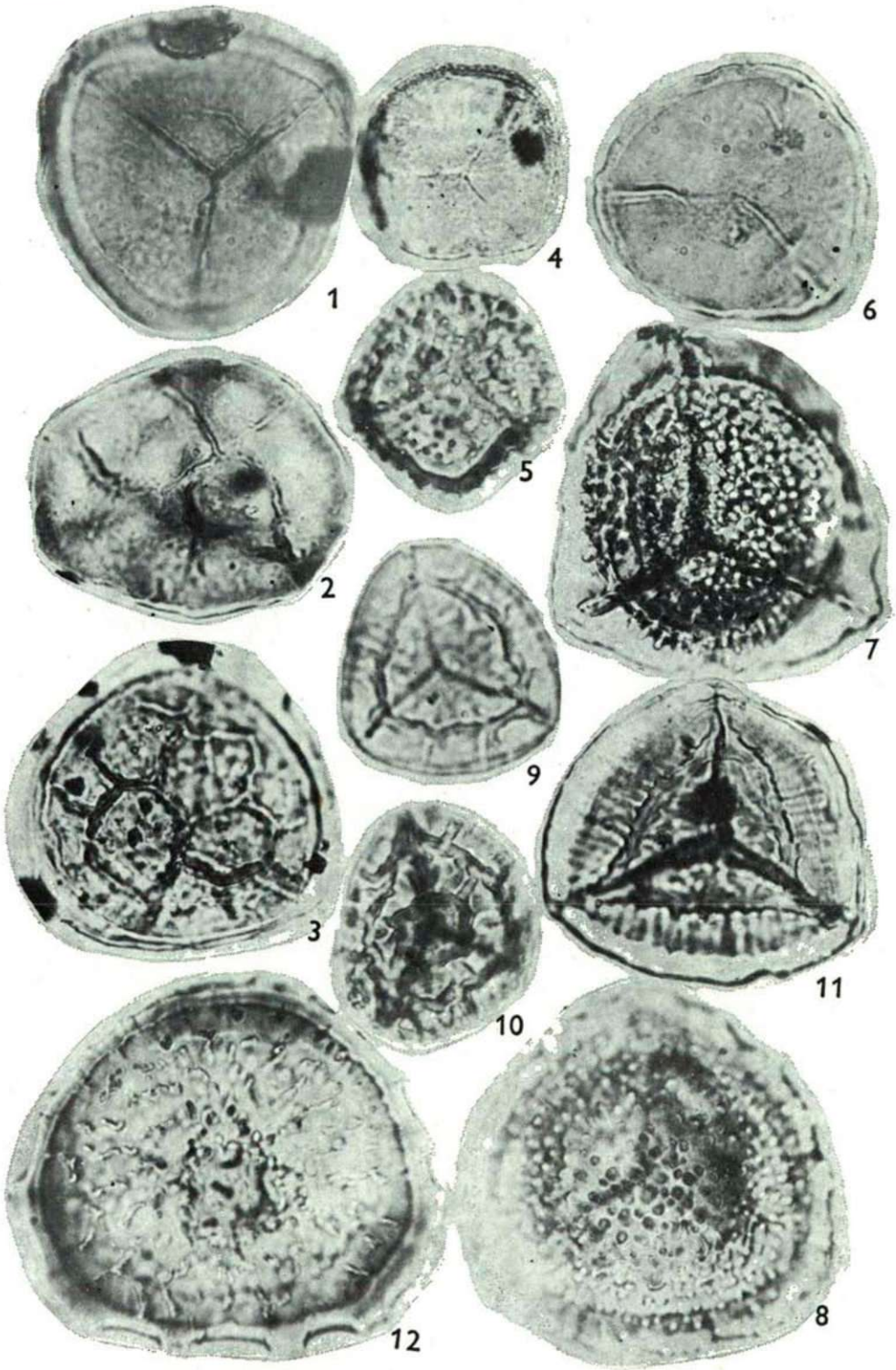
Genus: Foraminisporis W. KR. 1959

Remarks: KRUTZSCH (1963a) placed some of the Anthocerotaceae spores from Tertiary deposits into this genus. In the same year (1963), DETTMANN placed those of the Australian Lower Cretaceous spores were similar to the spores of the extant *Nothotylas breutelli* GOTTSCHE and *Phaeoceros bulbiculosus* (BROT.) PROSK. species, into the *Foraminisporis* W. KR. genus. *Foraminisporis* is also considered

Plate I

1. *Phaeocerosporites purus* (DEÁK 1964) n. comb. Tés, Tt-27. 50,5 m/1. P:32,5/108,8. Middle Albian
2. *Triporoletes radiatus* (DETTMANN 1963) PLAYFORD 1971 Süttő-3, 125/1. P:39,4/108,2. Lower Albian
3. *Triporoletes reticulatus* (POCOCK 1962) PLAYFORD 1971 Csehbánya, Cseh-5, 331,6/1. P:40/92,3. Middle Albian
4. *Foraminisporis dailyi* (COOKS. et DETT. 1958) DETTMANN 1963 Vértessomló. Vst-5, 48/2. P:35/98,4. Lower Albian
5. *Foraminisporis asymmetricus* (COOKS. et DETT. 1958) DETT. 1963 Olaszfalu, Pe-31, 131/2. P:34/101. Lower Cenomanian.
6. *Triporoletes simplex* (COOKS. et DETT. 1958) PLAYFORD 1971 Oroszlány. 0—1891, 509,5/1. P:40/100,7. Middle Albian
7. *Aequitriradites spinulosus* (COOKS. et DETT. 1958) COOKS. et DETT. 1961 Tés, Tt-27, 50,5/3. 113,5. Middle Albian
8. *Couperisporites clavatoides* (DEÁK 1964) n. comb. Tés, Tt-27, 32,2/1. P:29.3/108,2. Middle Albian
9. *Staplinisporites rotalis* DÖRING 1964 Sümeg, Süt-17, 322/1. P:43/95. Barremian
10. *Staplinisporites caminus* (BALME 1957) POCOCK 1962 Tatabánya, Ta-1495, 324/1. P:29,8/102. Lower Albian
11. *Coronatispora valdensis* (COUPER 1958) DETTMANN 1963) Szigetvár, Sz-3, 755/1. P:37,5/91. Albian
12. *Coptospora* sp. Olaszfalu, Ot-84, 109/1. P:39,4/107. Middle Albian

Plate I



by NORRIS (1967) as a bryophyte spore. JARZEN (1979) also described the spores of some extant Anthocerotaceae species. In a part of these spores, the foramen characteristic of *Foraminisporis* can be found. Others are rather similar to the *Phaeocerosporites described* by NAGY (1968).

Foraminisporis dailyi (COOKS. et DETT. 1958) DETT. 1963
(Plate I, Fig. 4)

Remarks: It has, together with *Foraminisporis asymmetricus*, a wide enough stratigraphic and geographic distribution in the Early Cretaceous. In the Hungarian sediments, it is a rare species.

Foraminisporis asymmetricus (COOKS. et DETT. 1958) DETT. 1963
(Plate I, Fig. 5)

Remarks: In the specimens investigated by me a great variety can be observed in the ornamentation of form, the size of foramen, and the shape. In the lower biozone of Vértessomló Formation, it is one of guide fossils.

Genus: Phaeocerosporites NAGY 1968

Remarks: This genus was created by NAGY (1968) for including the Anthocerotaceae spores having a distally rotund are but no foramen.

Phaeocerosporites purus (DEÁK 1964) n. comb.
(Plate I, Fig. 1)

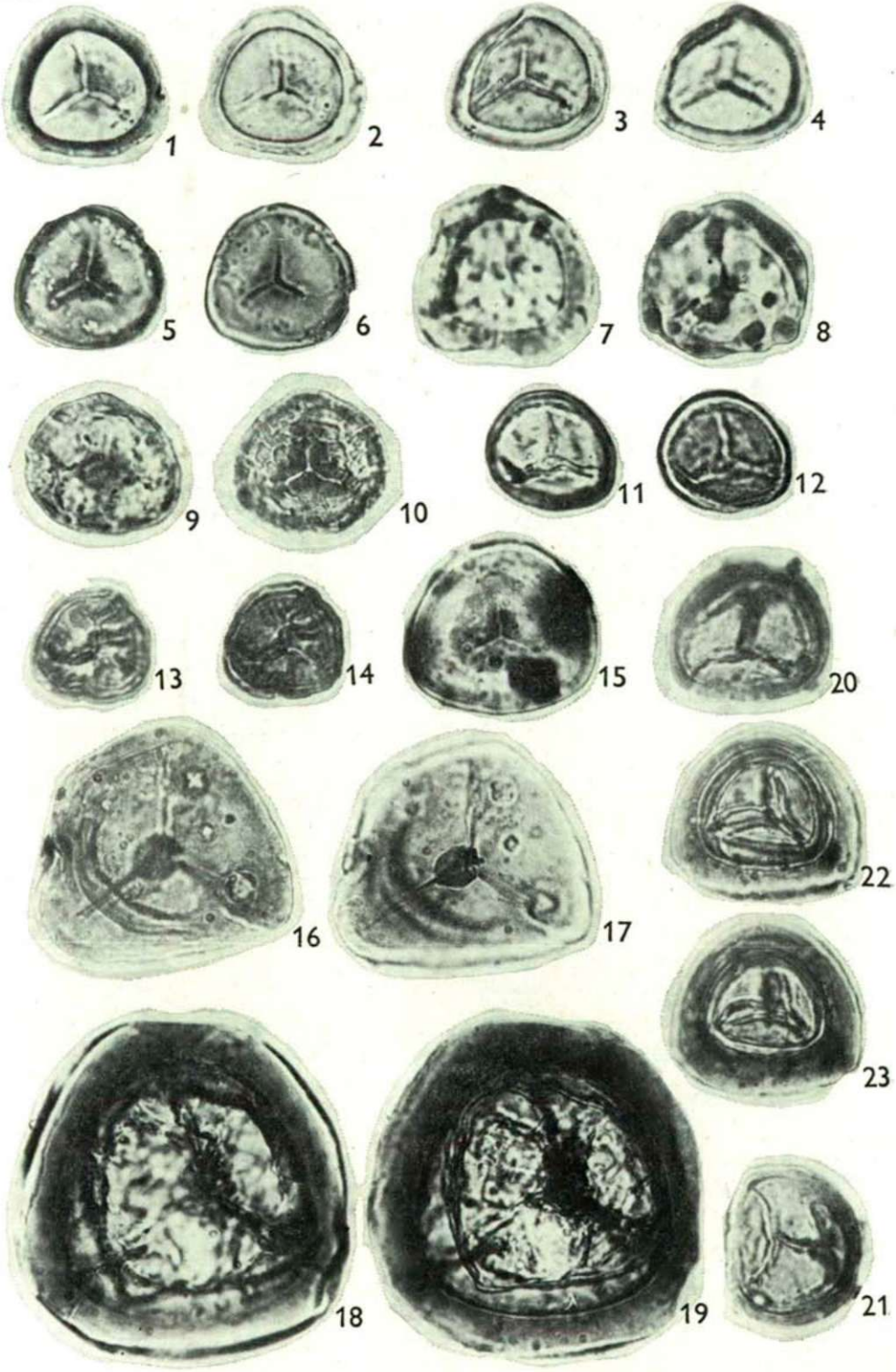
1964 *Purgatisporites purus* DEÁK, p. 109.

Remarks: The observed specimens have often a perisporium. This was emphasized by DEÁK (1964) when she created the *Purgatisporites* genus. We have been convinced by the study into several specimens and by the palaeo-ecological conditi-

Plate II

1—4. *Stereisporites psilatus* (ROSS 1949) PF. 1953 1,2=Balinka, Ba-237, 45/3. P:29/112,2. Upper Albian 3,4=Ba-237, 98/1. P:38,2/105,4. Upper Albian
5, 6. *Stereisporites antiquasporites* (WILSON et WEBSTER 1946) DETTMANN 1963 Tatabánya, Ta-1358, 369,5/1. P:28,4/97. Lower Albian
7. *Stereisporites aptiensis* (DEÁK 1964) n. comb. Süttő-3, 120/2. P:32,5/102,5. Lower Albian
8. *Stereisporites* cf. *grossus* TAKAHASHI 1964 Tatabánya, Ta-1495, 378/1. P:32,5/101,5. Lower Albian
9. *Stereisporites australis* (COOKSON 1953) n. comb. Ta-1495, 376/2. P:41/108,5. Lower Albian
10. *Stereisporites* sp_1. Ta-1329, 461/1. P:34,4/112,7. Neokomian
11, 12. *Stereisporites europeum* (BOLCH. 1953) CORNA 1972 Tés, Tt-27, 38,5/1. P:28,7/98. Middle Albian
13, 14. *Stereisporites apolaris* (REINH.) MIKI 1972 Sümeg, Süt-17, 245/1. P:39/98,1. Lower Aptian
15. *Stereisporites antiquasporites* (WILSON et WEBSTER 1946) Dettmann 1963 Vértessomló, Vst-5, 43,2/1. P:45,2/103.4. Lower Albian
16, 17. *Stereisporites* sp_2. Süttő-3, 108/2. P:33,3/98,4. Lower Albian
18, 19. *Cingutriletes* sp. Csehbánya, Cseh-5, 263/1. P: 34,3/102,2. Middle Albian
20, 21. *Cingutriletes levispeciosus* (PF. 1953) n. comb. Oroszlány, 0—1891, 578/1. P:41,7/104,9. Middle Albian
22, 23. *Cingutriletes clavus* (BALME 1957) DETT. 1963 Sur-1, 520/2. P:29/99,1. Middle Albian

Plate II



ons of the species that the spore in question is that of Anthocerotaceae, at the distal surface of which the rotund area is expressed enough. It is characteristic species of the swamp-bog vegetation of the Tés Formation.

Classis: Bryopsida

Subclassis: Sphagnidae

Familia: Sphagnaceae

Of the Cretaceous spores, the species of the *Stereisporites* TH. et PF. and *Cingutriletes* Pierce genera are classed into the family.

Genus: Stereisporites TH. et PF. 1953

Remarks: The *Stereisporites* genus was divided by KRUTZSCH (1963b) and DÖRING et al. (1966) into several subformgenera. In the "large genus", created in this way, a strong morphological heterogeneity may be observed. The botanical relationship of *Stereisporites* can be queried on this basis. We have been convinced by the investigations carried out on the recent Sphagnaceae spores (BOROS and JÁRAI—KOMLÓDI 1975; TALLIS, 1962; TERASME, 1955) that it is more justified to treat *Stereisporites* according to the genus conception created by THOMSON et PFLUG (1953) and used in the Lower Cretaceous palynology.

Stereisporites psilatus (ROSS 1949) PF. 1953
(Plate II, Figs. 1—4)

Stereisporites antiquasporites (WILSON et WEBSTER 1946) DETT. 1963
(Plate II, Figs. 5, 6, 15)

Stereisporites aptiensis (DEÁK 1964) n. comb.
(Plate II, Fig. 7)

1964 *Stenozonotriletes aptiensis* DEÁK, p. 111—112.

Remarks: In this form, the comparatively wide cingulum is less rounded in at two of the three corners. It is a rare species of the Tés Formation.

Stereisporites cf. *grossus* TAKAHASHI 1964
(Plate II, Fig. 8)

Stereisporites europeum (BOLCH. 1953) ČORNA 1972
(Plate II, Figs. 11—12)

Stereisporites australis (COOKSON 1953) n. comb.
(Plate II, Fig. 9)

1953 *Sphagnites australis* COOKSON, p. 464.

Stereisporites apolaris (REINH. 1961) MIKI 1972
(Plate II, Figs. 13, 14)

Stereisporites sp.$_1$
(Plate II, Fig. 10)

Stereisporites sp.$_2$
(Plate II. Figs. 16, 17)
Genus: Cingutriletes (PIERCE 1961) DETT. 1963

Remarks: KRUTZSCH (1963b) reduced *Cingutriletes*, created by PIERCE (1961), into one of the subformgenera of *Stereisporites*. DETTMANN (1963) emended the PIERCE's genus and listed its synonym, as well.

As to its botanical relationship, DETTMANN (1963), NORRIS (1967), and SINGH (1971) pronounced in favour of Sphagnaceae.

Cingutriletes clavus (BALME 1957) DETT. 1963
(Plate II, Figs. 22, 23)

Cingutriletes levispeciosus (PF. 1953) n. comb.
(Plate II, Figs. 20, 21)

Cingutriletes sp.
(Plate II, Figs. 18, 19)

Distribution: The above-mentioned *Stereisporites* and *Cingutriletes* species sporadically occur in the Hungarian Lower and Middle Cretaceous sediments. Their stratigraphic distribution, with the other bryophyte spores of Hungarian Early Cretaceous, are illustrated on the Table I.

Subclassis: Bryidae

Of the Lower and Middle Cretaceous spores, *Staplinisporites* and the *Coronatispora* formgenera show some similarity with the present-day moss spores. DETTMANN (1963) called the attention to the similarity between the recent moss spore *Encalypta ciliata* (HEDV.) HOFFM. and *Staplinisporites*. ČORNA (1968), SRIVASTAVA (1975) ranged the above formgenus among moss spores, while FILATOFF (1975) supposed a Lycopodiaceae relationship. On the basis of the ring at the distal surface of spore, I suppose that *Staplinisporites* and the *Coronatispora* are Bryidae.

Genus: Staplinisporites POCOCK 1962
Staplinisporites rotalis DÖRING 1964
(Plate I, Fig. 9)

Remarks: In the Hungarian sediments, this species exclusively occurs in Neocomian, in a low number of specimens.

Staplinisporites caminus (BALME 1957) POCOCK 1962
(Plate I, Fig. 10)

Remarks: This species is, together with some other forms, the characteristic species of the lower biozone of Vértessomló Formation.

Genus: Coronatispora DETT. 1963

Syn.: *Spinaecoronatisporites* DEÁK, p. 102.

Remarks: The opinions of some authors differ in respect of the problems of

nomenclature and priority. I accepted SRIVASTAVA's view (1975) who regards as a differential sign from the Staplinisporites the presence of interradial crassitudes.

Coronatispora valdensis (COUPER 1958) DETT. 1963
(Plate I, Fig. 11)

Conclusions

Of the spores of the Hungarian Early Cretaceous sediments, I have classed 24 species of ten genera — on the basis of their characteristic marks — among Bryophyta; from among them, the representatives of *Triporoletes, Aequitriradites, Coupe-*

Table 1. Stratigraphic distribution of Bryophyta spores from Hungarian Lower-and Middle Cretaceous.

	Bersek Formation	Sümeg Formation A	Sümeg Formation B	Tata Formation	Vértessomló Formation A	Vértessomló Formation B	Tés Formation	Pénzeskút Formation A	Pénzeskút Formation B
	Neocomian		Aptian		Albian				Low. Cen.
Staplinisporites rotalis	+	+							
Stereisporites sp_1.		+							
Stereisporites apolaris		+	+						
Stereisporites europeum			+	+	+		+		
Stereisporites australis			+		+				
Stereisporites cf. grossus					+	+			
Staplinisporites caminus				+	×	+			
Aequitriradites spinulosus		+			+		××	+	
Stereisporites sp_2.					×	+			
Stereisporites antiquasporites					+	+			
Triporoletes radiatus					×	+			
Triporoletes simplex					+	+	+		
Stereisporites aptiensis					+	+	×		
Foraminisporis dailyi						×	+		
Cingutriletes clavus							+	+	
Foraminisporis asymmetricus					××	+		+	+
Cingutriletes levispeciosus							+	+	
Triporoletes reticulatus							××	+	
Coronatispora valdensis							×	+	
Couperisporites clavatoides							××	+	
Phaeocerosporites purus							×	+	+
Coptospora sp.							+		+
Cingutriletes sp.								×	+

\+ rare
× common
×× very common

risporites, and *Coptospora* genera (six species) among Hepaticopsida; three species of Foraminisporis and Phaeocerosporites among Anthoceropsida. From the Sphagnidae subclass *Stereisporites* (nine species) and *Cingutriletes* (three species), from the Bryidae subclass *Staplinisporites* and *Coronatispora* (three species) have represented the Bryopsida. It can be established that Bryophyta played no important role in the studied microflora. According to the statement of SAMOILOVICH et al. (1973), in the areas above 60° Kr. N, in forming the Aptian-Albian microflora, the *Sphagnum* moors of wide extension had a considerable part. On the territory of that time of the present-day Hungary of tropic-subtropic climate, peat mosses had a subordinate role. Although I have identified most species from Sphagnaceae spores, the specimens of these were of very low number in each of the sporomorphe assemblages. The liverwort spores took a more important part than these in the Tés Formation. In the course of this sediments cycle, fresh-water assemblages of lagoon character developed and the sporomorphes of some rock samples give proof of the development of a coastal swamp vegetation. Thus, in the district of Olaszfalu and Tés, from the coaly-clayey samples, the following hornwort and liverwort spores were dominantly found: *Phaeocerosporites purus, Couperisporites clavatoides, Aequitriradites spinulosus, Triporoletes reticulatus, Coptospora* sp.

This indicates that in the swamp vegetation, apart from swampy ferns, Anthoceropsida and Hepaticopsida lived in the highest number. In the marine sediments, however, their part was entirely subordinated, even in the rocks of younger age.

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